Interactive Stereoscopic Display for Three or More Users

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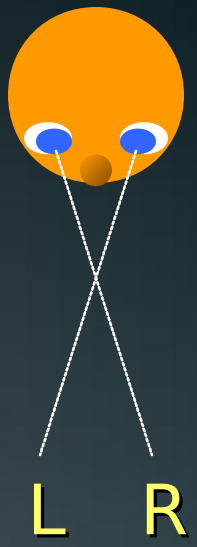
3D Images

- Holography

- Stereoscopic Images

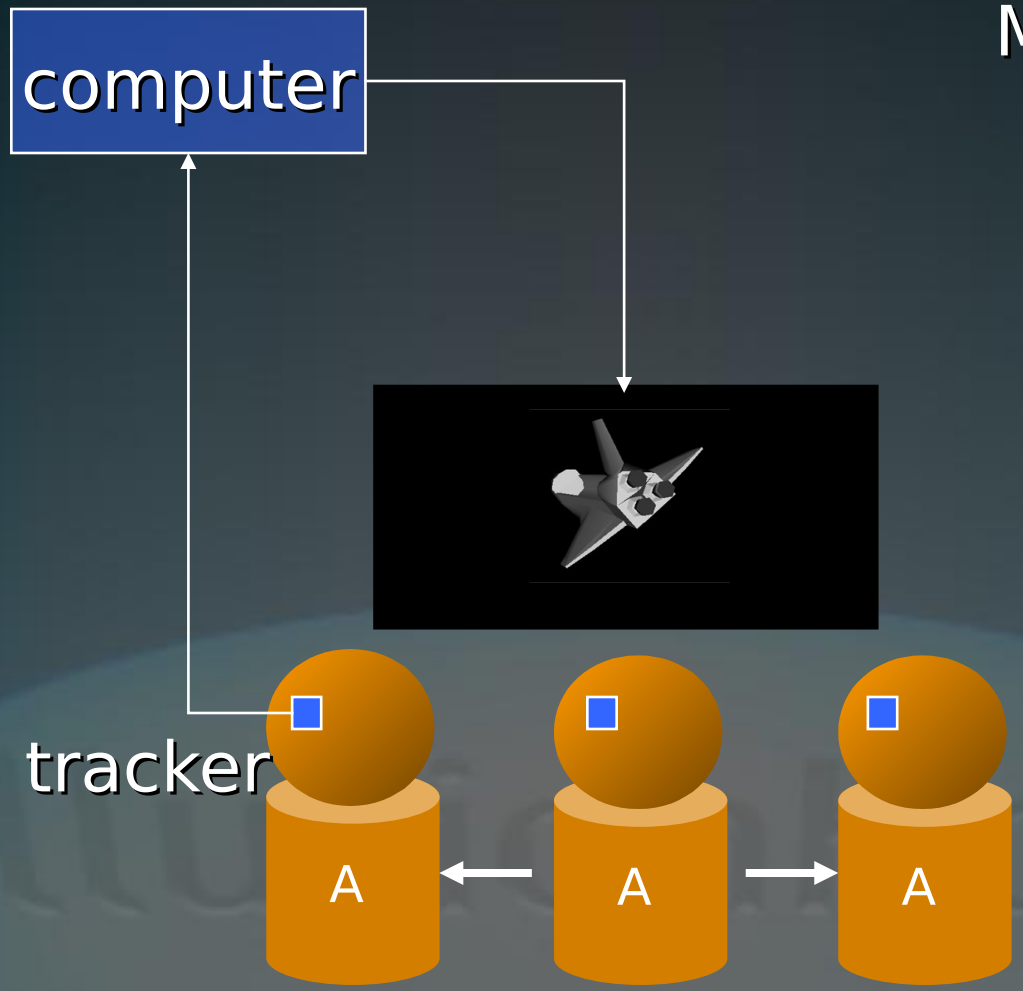
Interactive Stereoscopic Display



IllusionHole

Interactive Stereoscopic Display

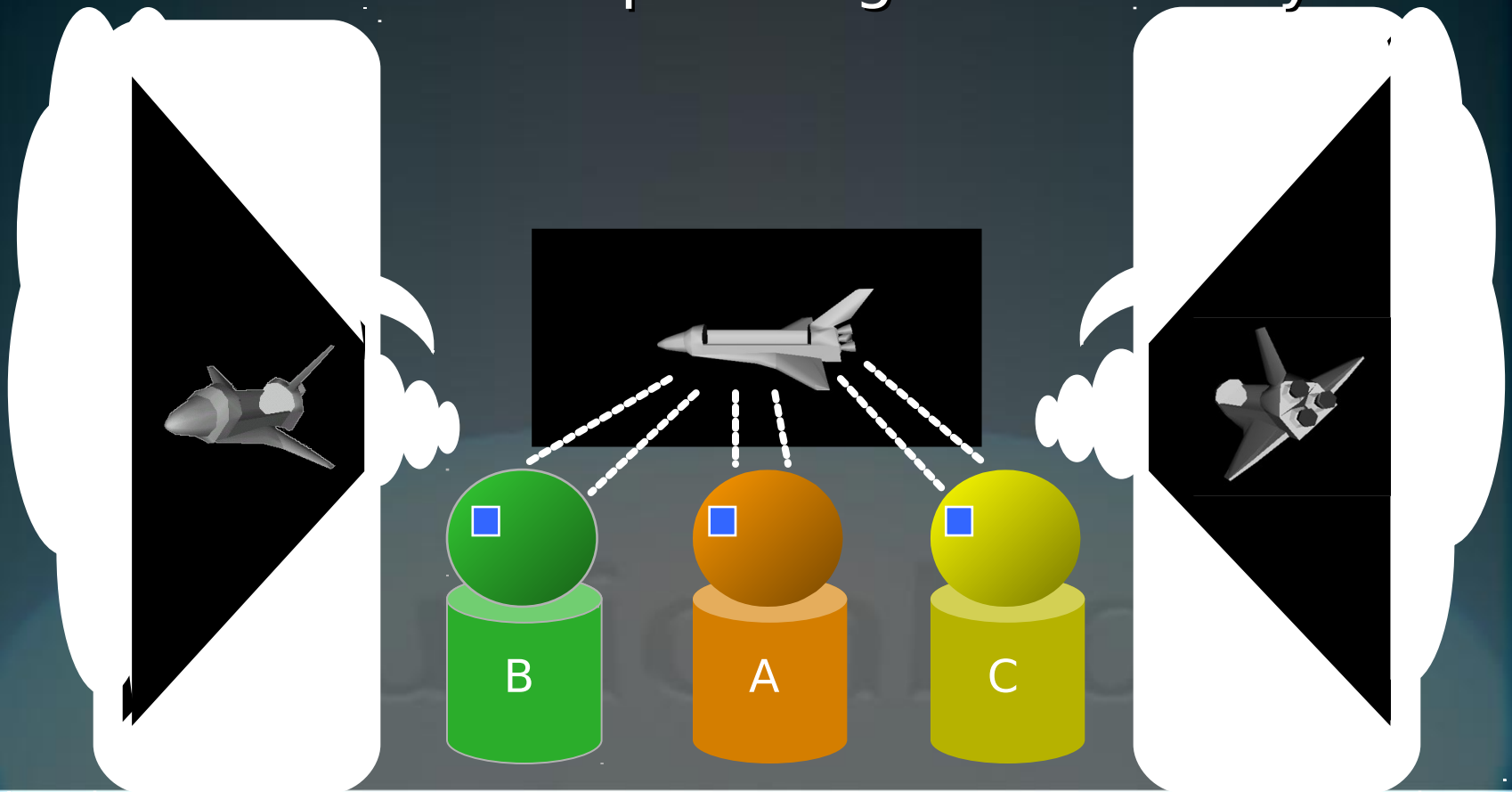
Motion parallax

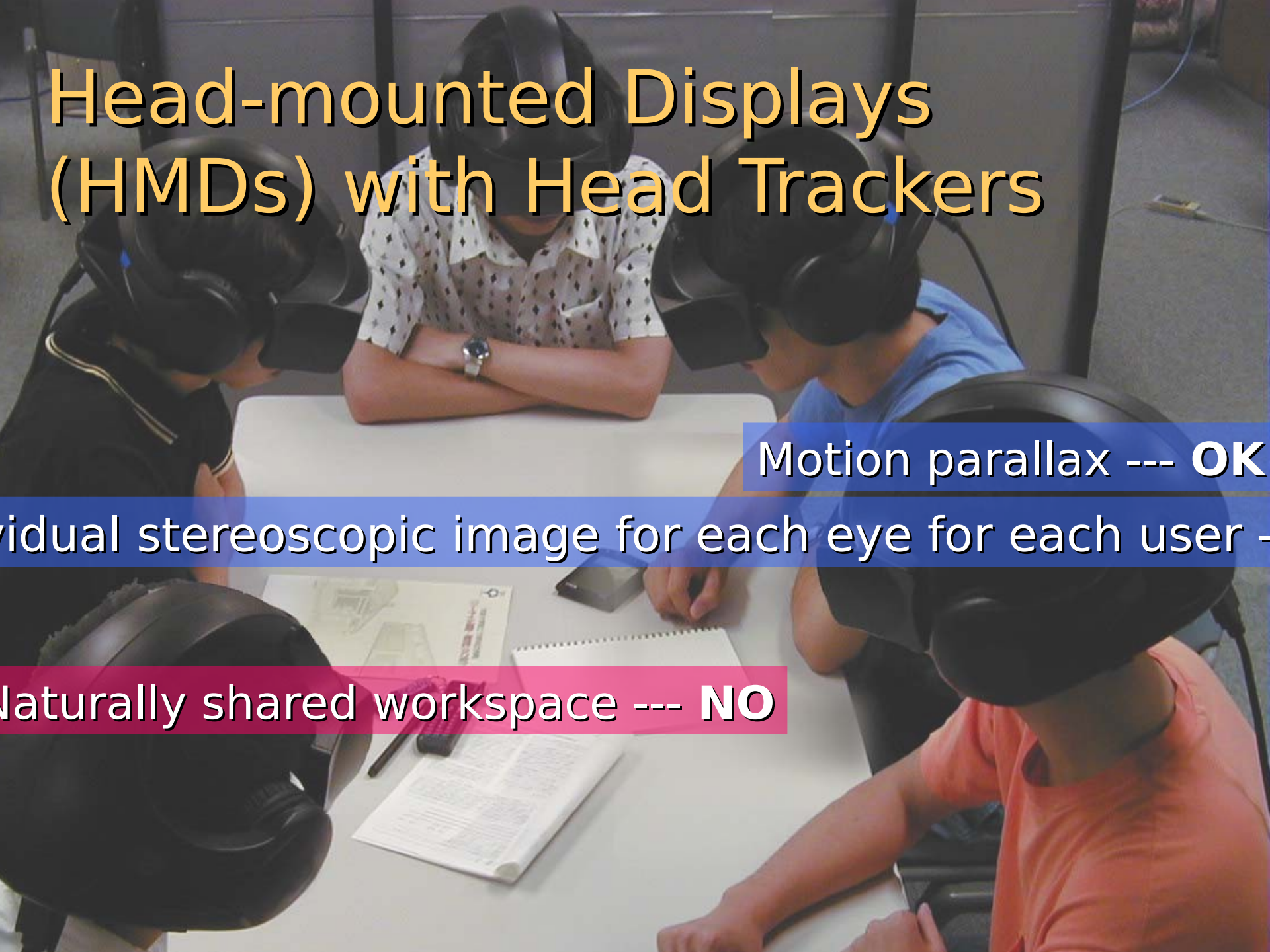


Interactive Stereoscopic Display for Multiple Users

Motion parallax

Individual stereoscopic image for each eye of each




Head-mounted Displays (HMDs) with Head Trackers
Motion parallax --- OK
vidual stereoscopic image for each eye for each user -
Naturally shared workspace --- NO

Possibilities for Stereoscopic Display Techniques

- Anaglyph …… glasses with red and blue lenses
- Polarization
  - Linear polarization filters ……face cannot be tilted
  - Circular polarization filters……property varies with different visible rays
- Stereoscopic display without glasses
  - Parallax barrier
  - Lenticular

- Field-sequential shutter glasses
  - LCD shutter glasses

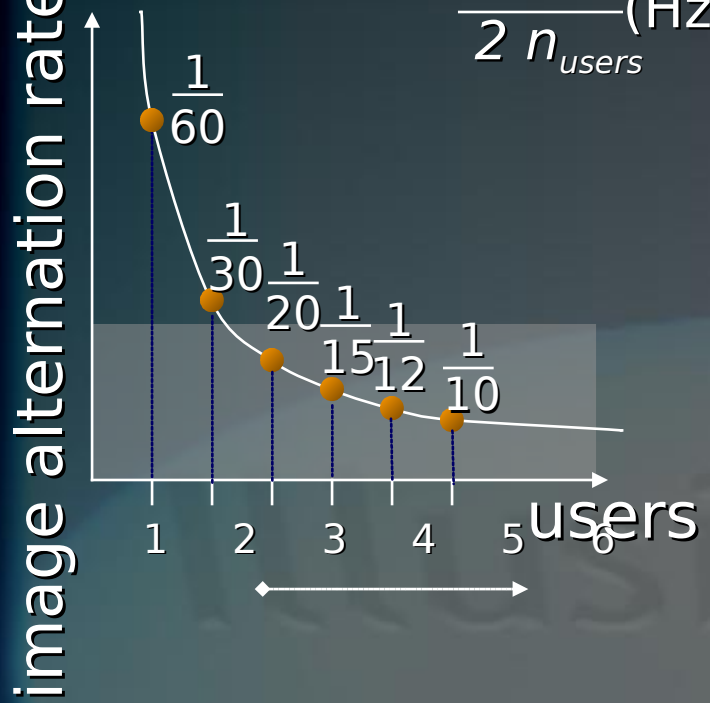
Adaptation for multiple users: Difficult

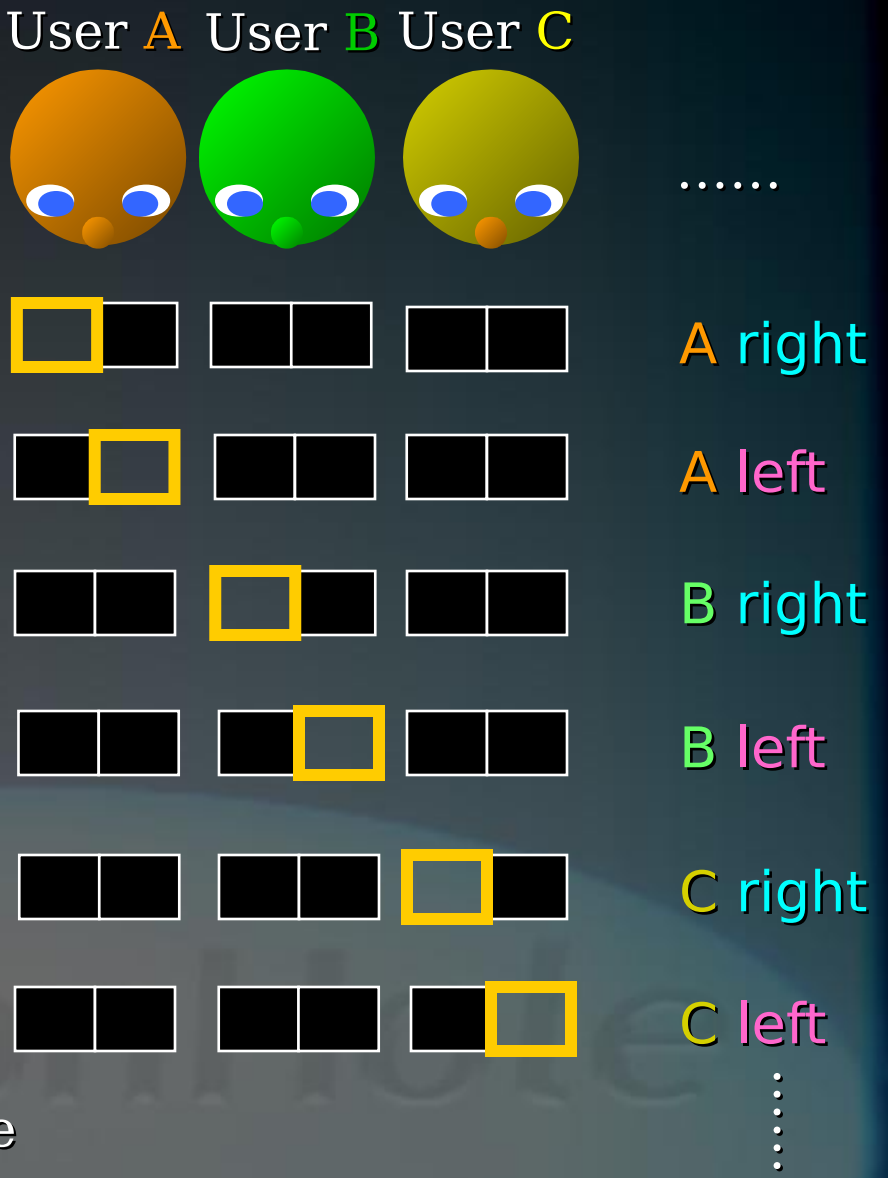
Widely Used

Field-sequential Stereoscopic Display

with shutter glasses

$$\frac{120}{2\ n_{users}}\text{(Hz)}$$





Proposal

Ideal Interactive Stereoscopic Display for Three or More Users

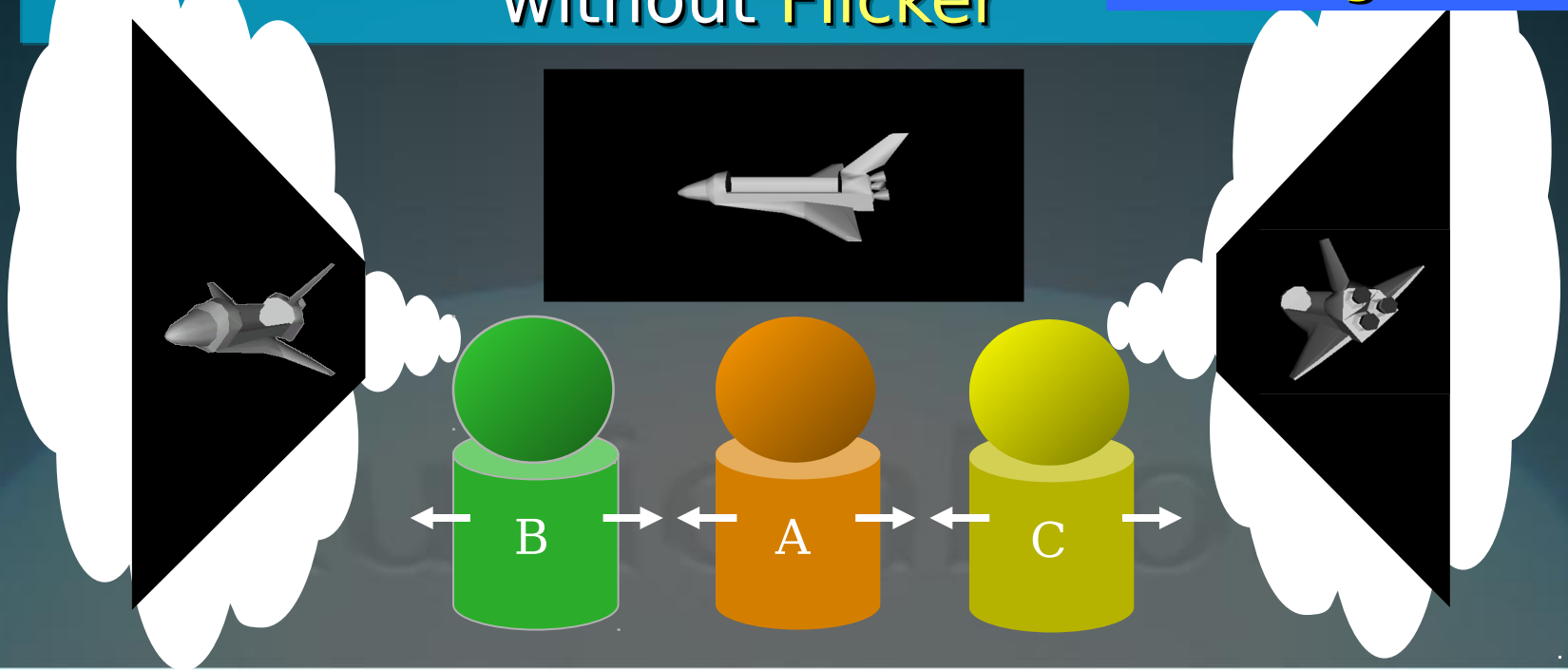
ndividual stereoscopic image pair for each viewpoint

with Motion parallax

without Distortion

without Flicker

with very simple configuration



Principle of IllusionHole

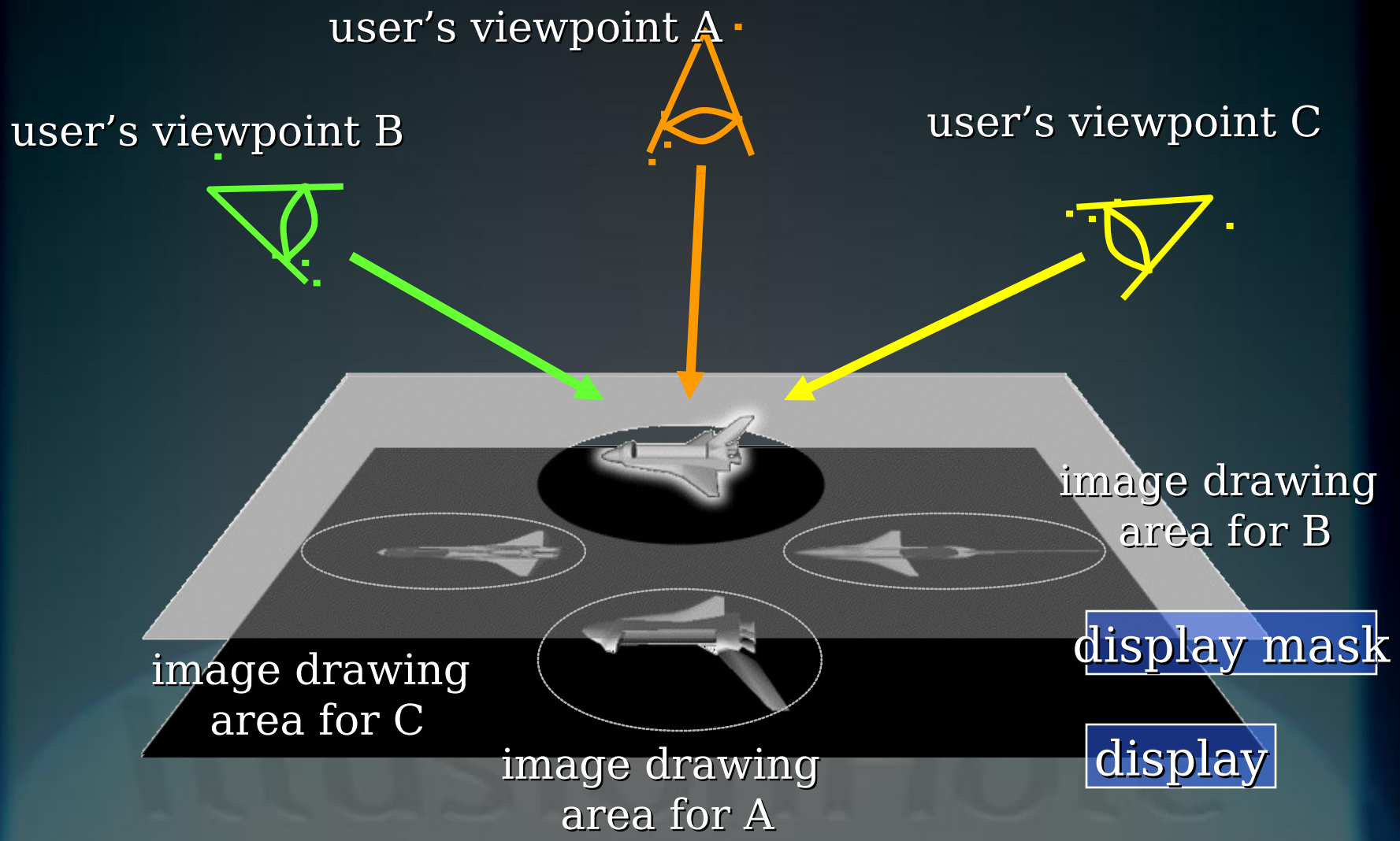
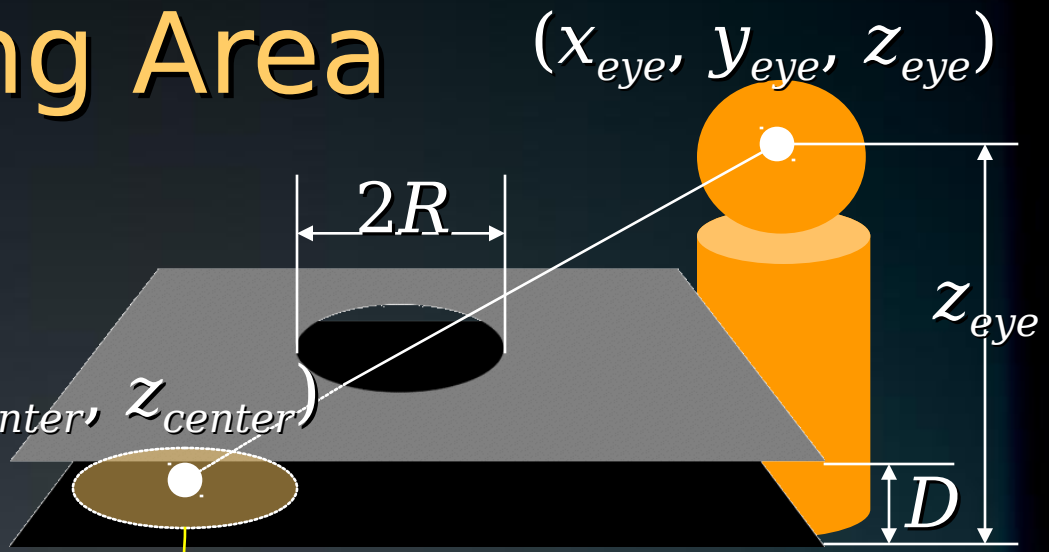


Image Drawing Area



position

$$\begin{cases} x_{center} = -x_{eye} \cdot \dfrac{D}{z_{eye} - D} \\ y_{center} = -y_{eye} \cdot \dfrac{D}{z_{eye} - D} \\ z_{center} = 0 \end{cases}$$

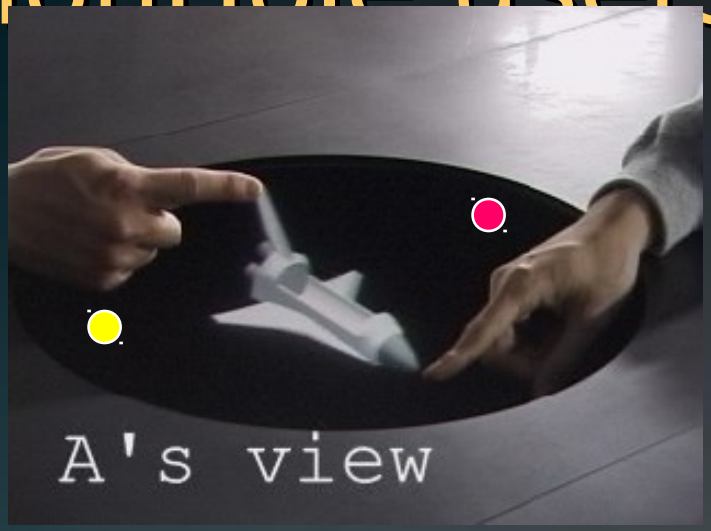
radius

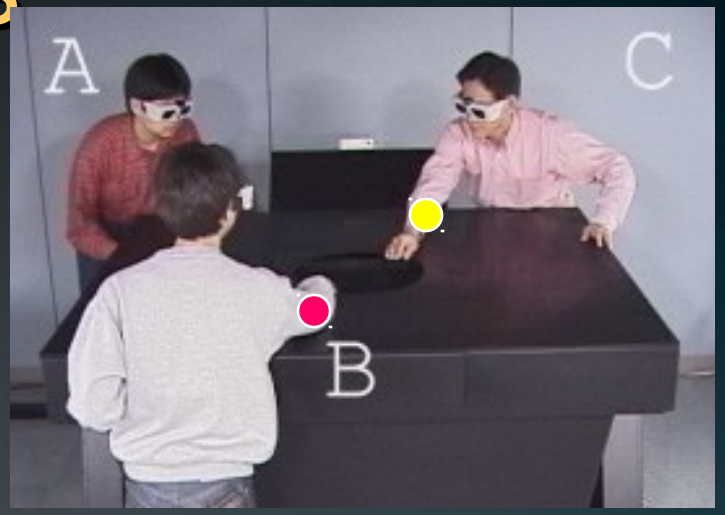
$$r = R \times \frac{z_{eye}}{z_{eye} - D}$$

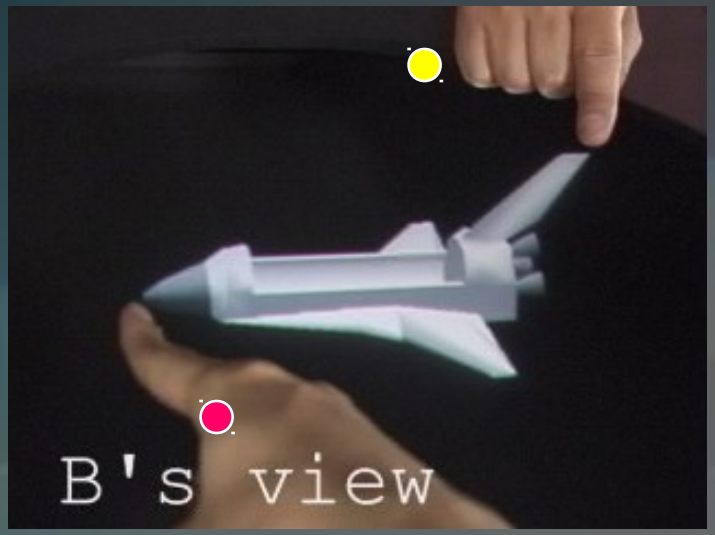
illusionHole

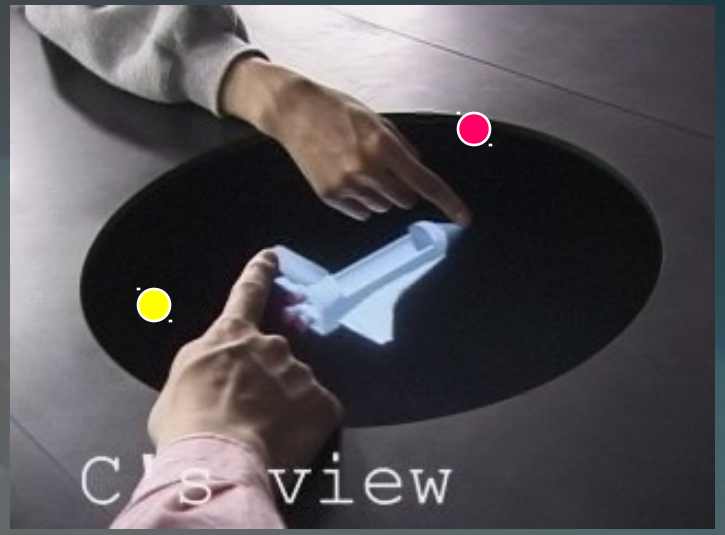
Video

Collaboration among three IllusionHole users





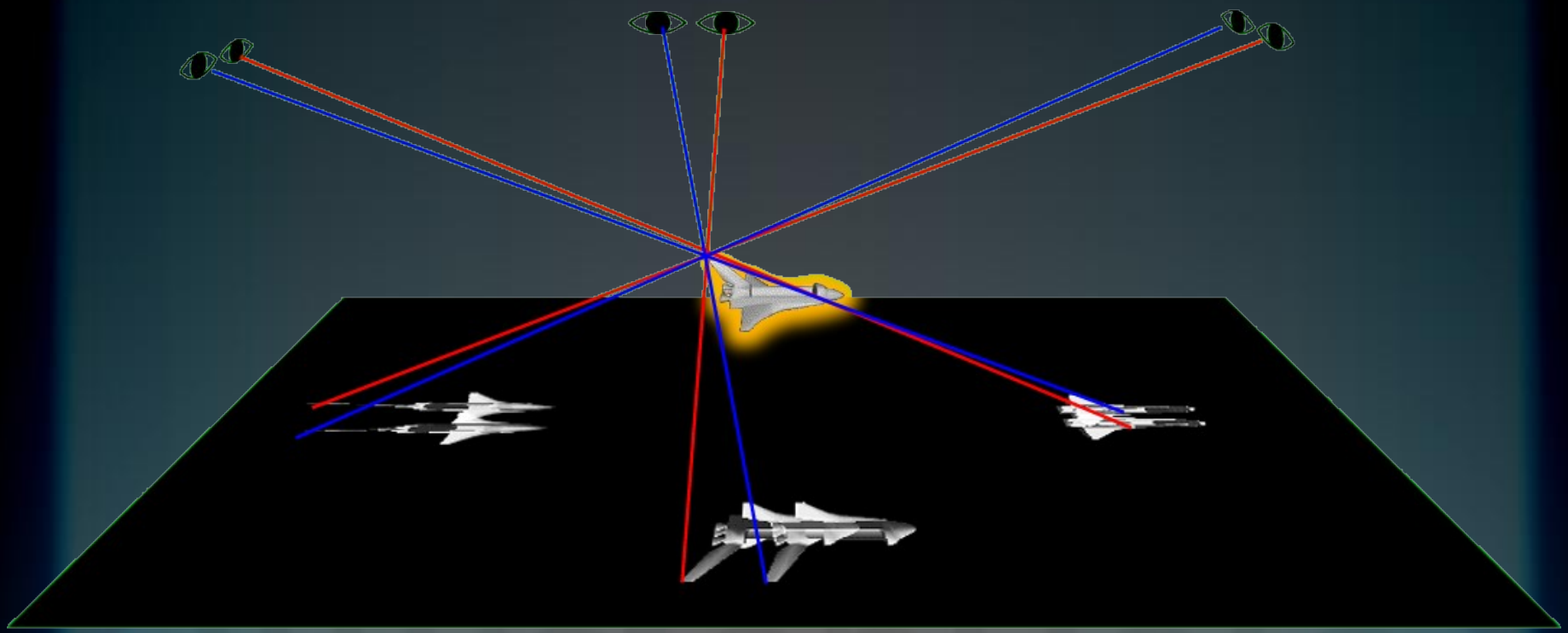




B's hand

C's hand

Presentation of Stereoscopic Images



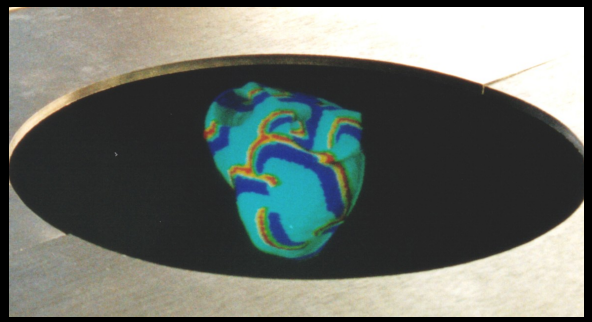
IllusionHole Shared by Four Users

user B

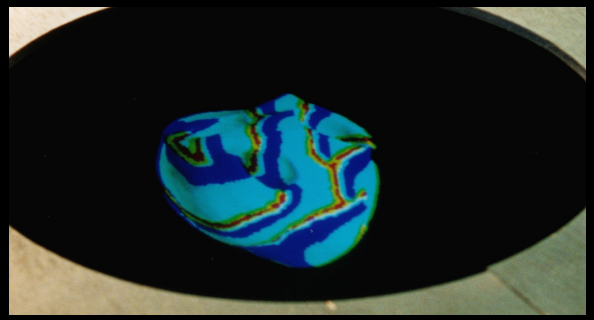
user C

user A

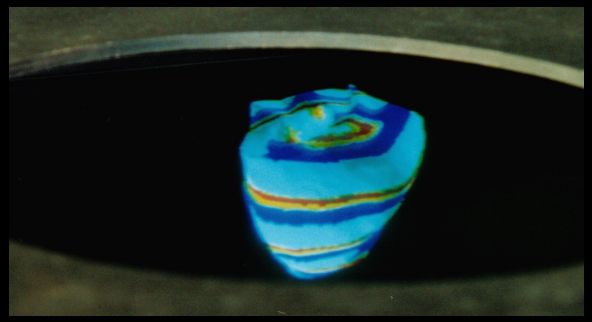
Human Heart (National Cardiovascular Center Research Inst



A’s view

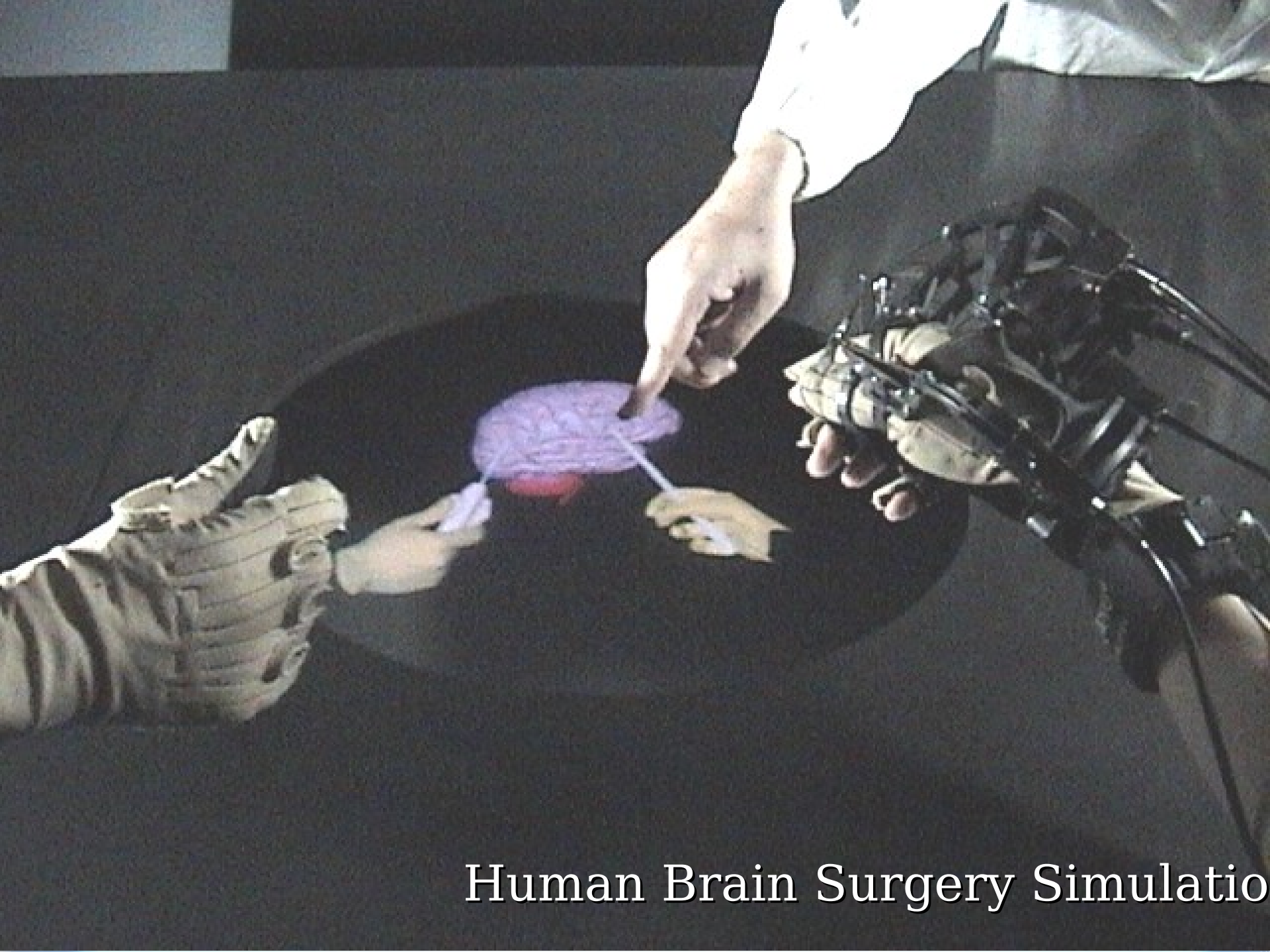


B’s view



C’s view

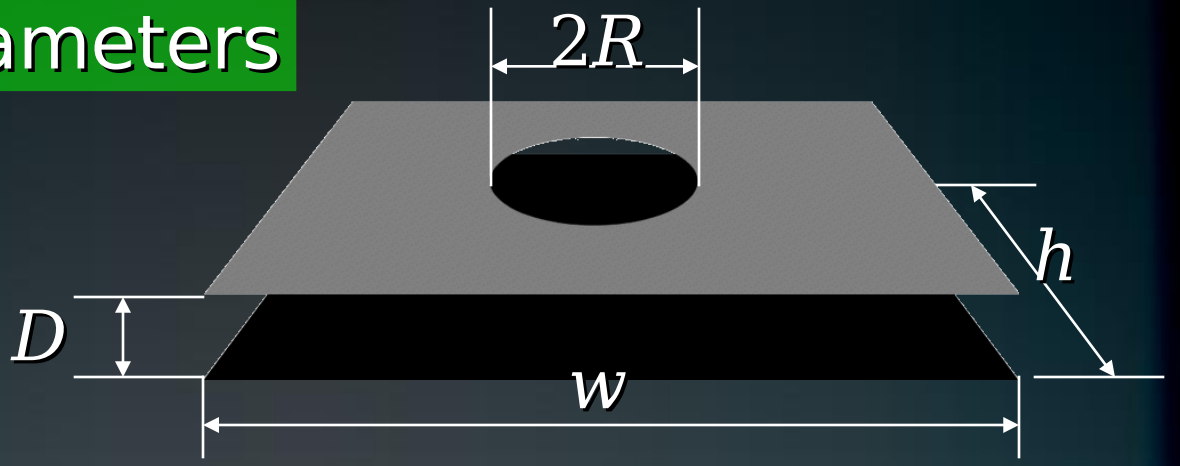
IllusionHole
Shared by Four Users
user B
user A
user C
Human Brain
A's view
B's view
C's view


Human Brain Surgery Simulatio

IllusionHole

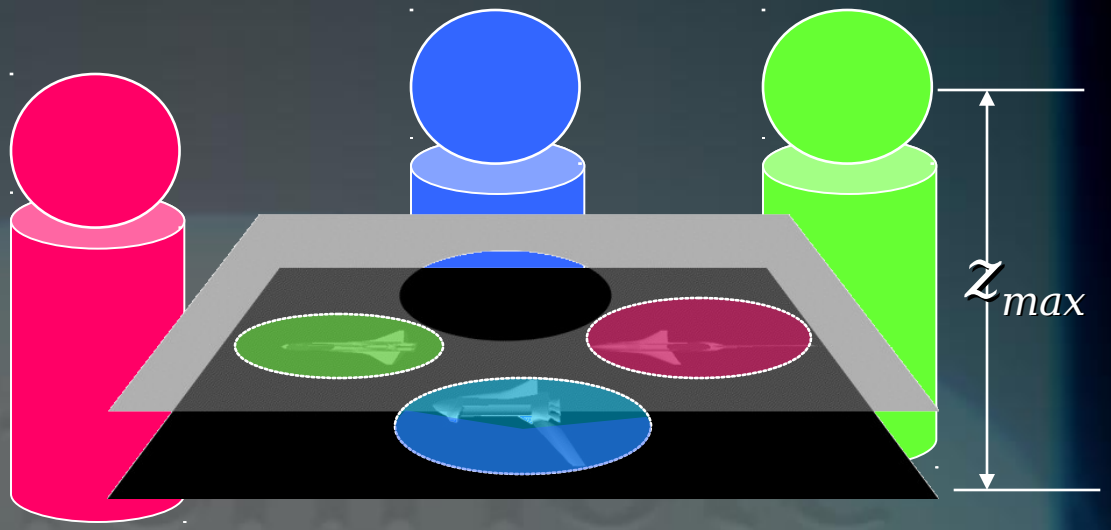
Design of IllusionHole

Basic Design Parameters



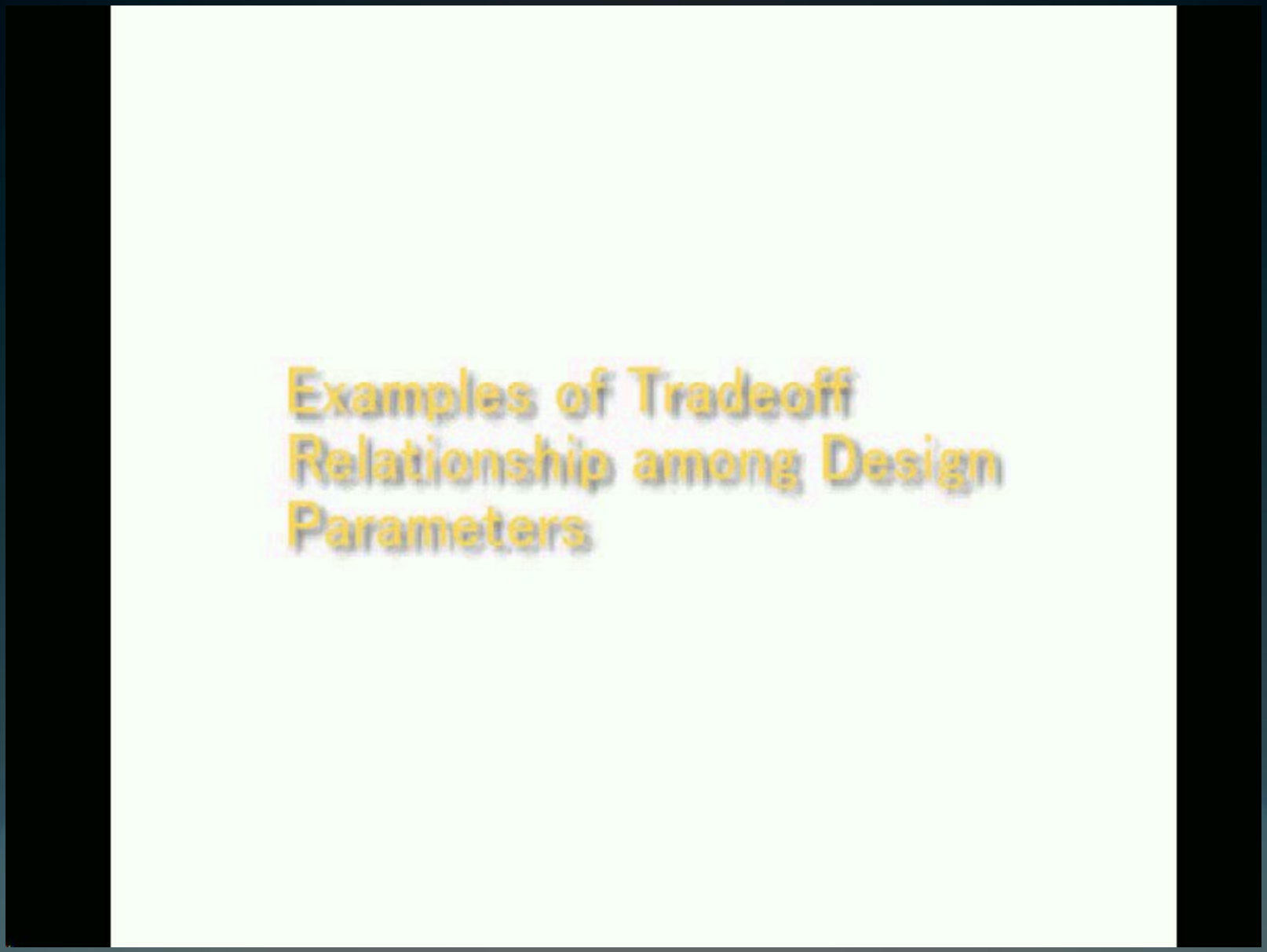
Requirements

- image drawing area
  - does not exceed
  - does not overlap
- $z_{eye} < z_{max}$



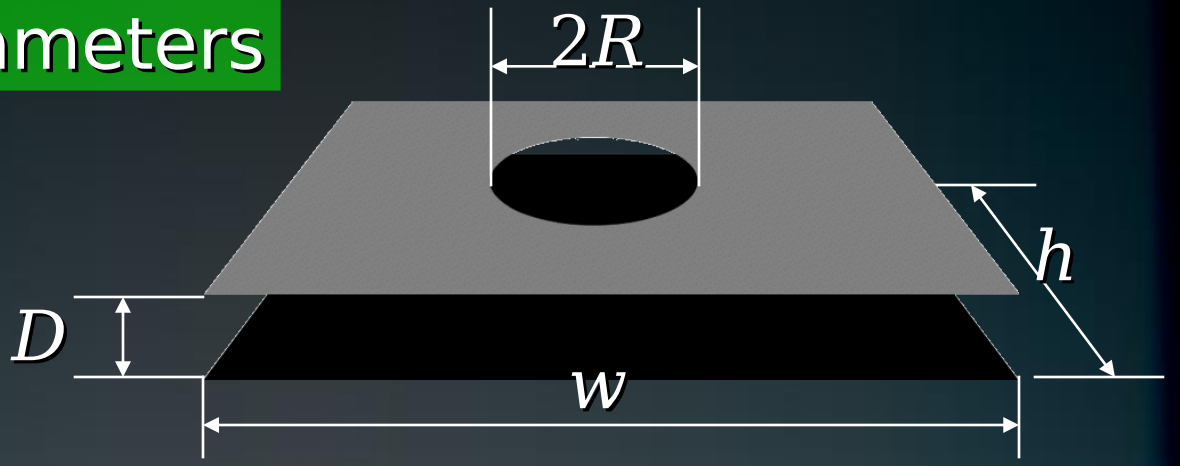
Trade-off Relationship

Video


Examples of Tradeoff
Relationship among Design
Parameters

Variation of Characteristics

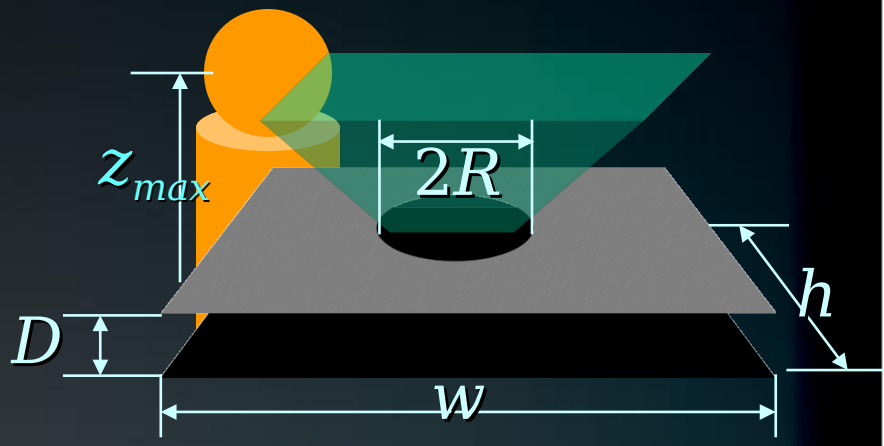
Basic Design Parameters



Characteristics of IllusionHole

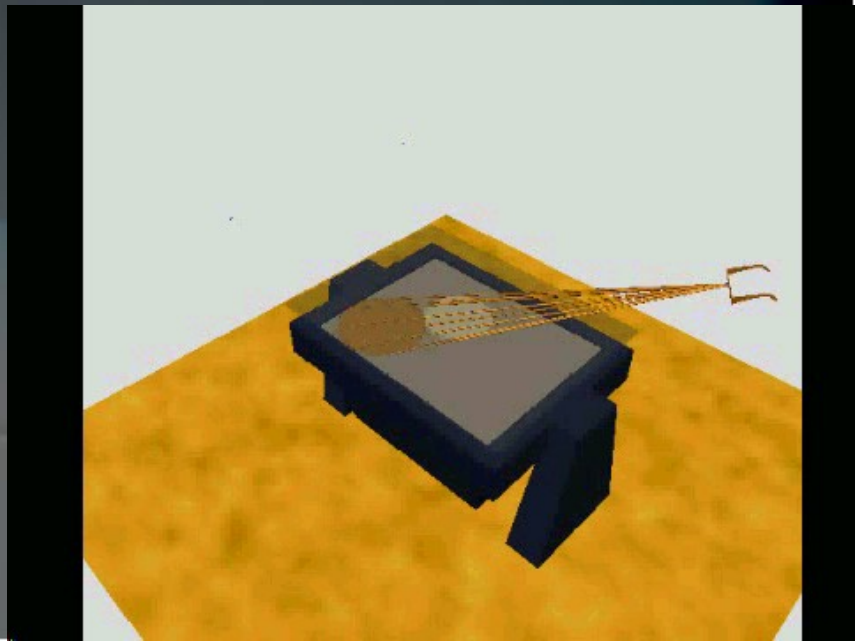
- Movable Volume for a User
- Viewing Angle between Users
- Viewing Volume for a User
- Maximum Number of Users

Movable Volume for a User

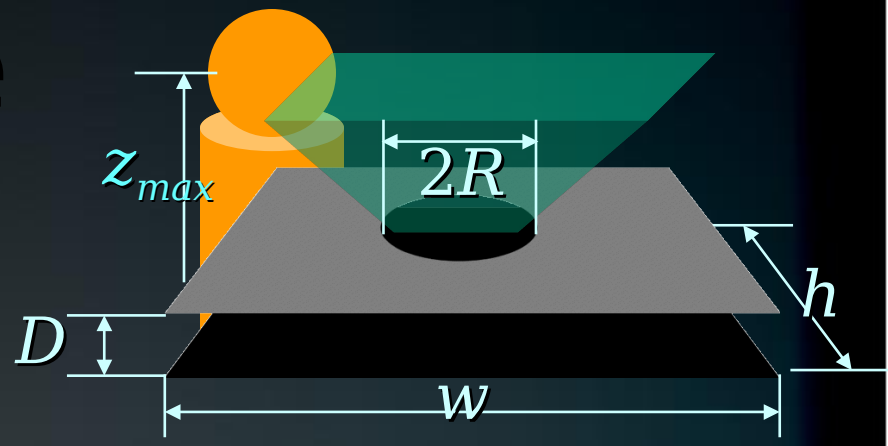


$$V_m = \frac{(w - 2R)(h - 2R)}{3D^2}$$

$$\left[z_{\max} + \frac{D(3R \cdot w - R \cdot h - w \cdot h)}{(w - 2R)(h - 2R)} \right] z_{\max} - \frac{D \cdot h}{h - 2R}^2$$



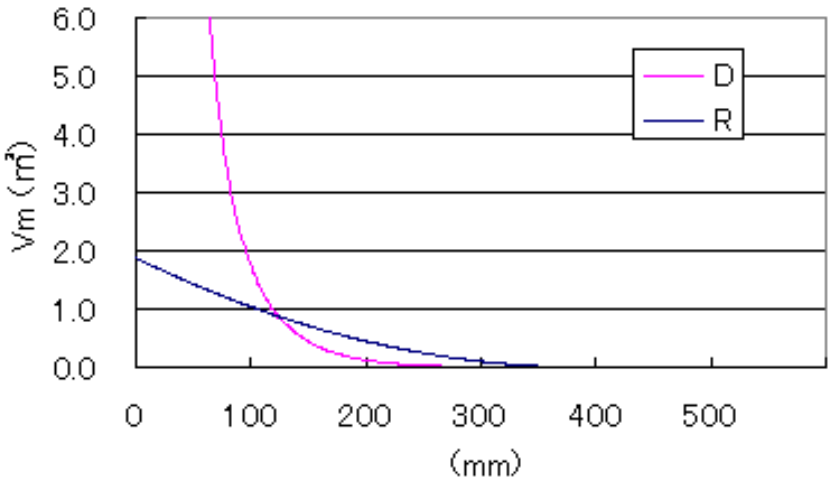
Movable Volume for a User

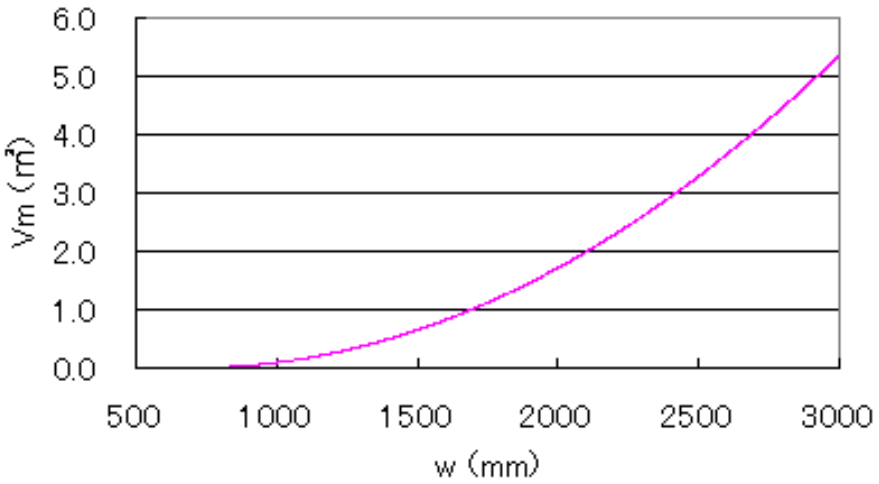


$$V_m = \frac{(w-2R)(h-2R)}{3D^2}$$

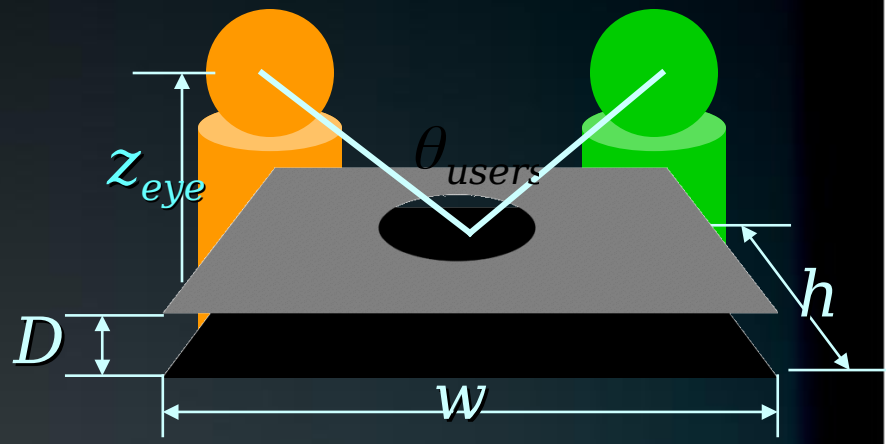
$$\cdot\left[z_{\max} + \frac{D(3R\cdot w - R\cdot h - w\cdot h)}{(w-2R)(h-2R)}\right]\left[z_{\max} - \frac{D\cdot h}{h-2R}\right]^2$$

$w : h = 4 : 3$

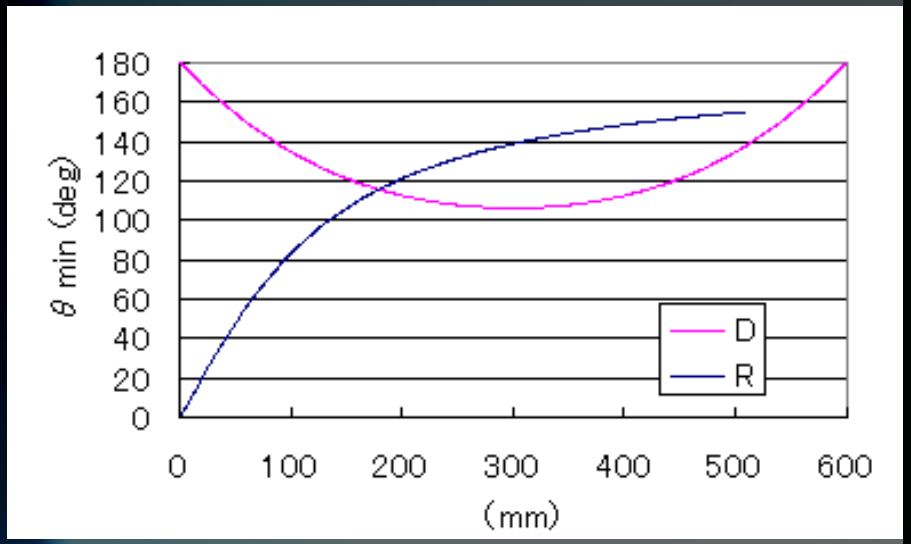


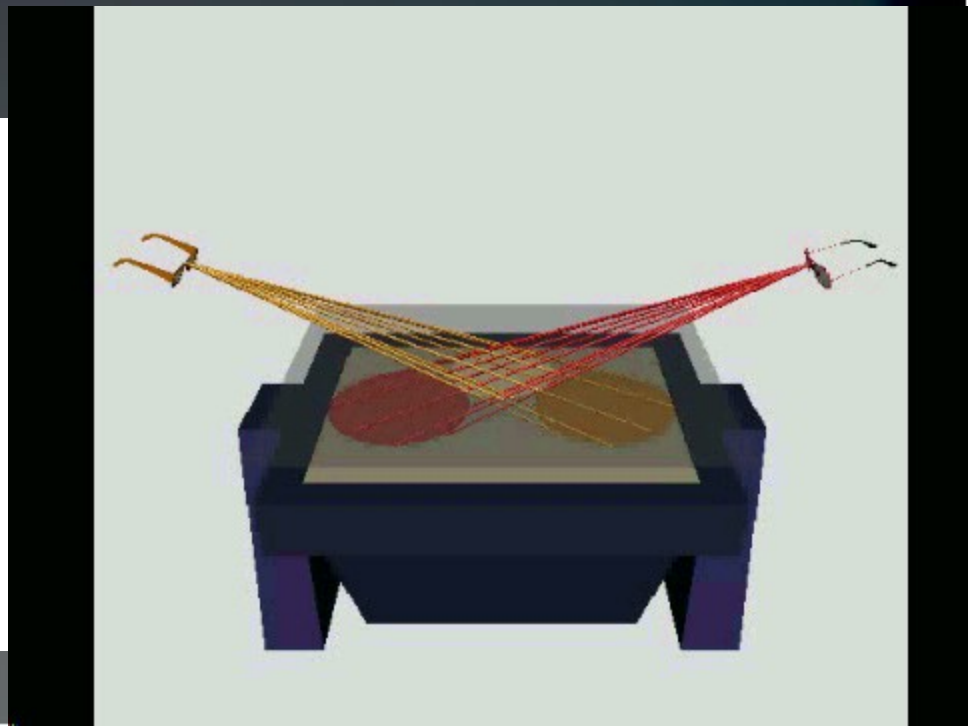


Viewing Angle between Users



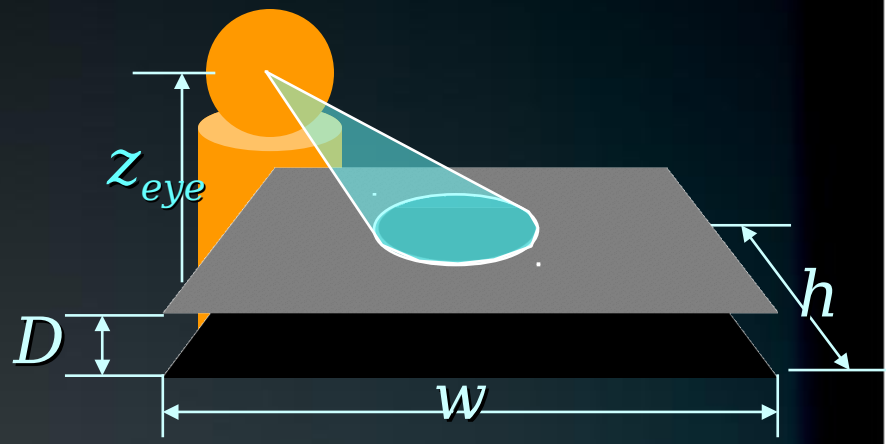
$$\theta_{users} \geq 2\arctan\left[\frac{R \cdot z_{eye}}{D(z_{eye} - D)}\right]$$

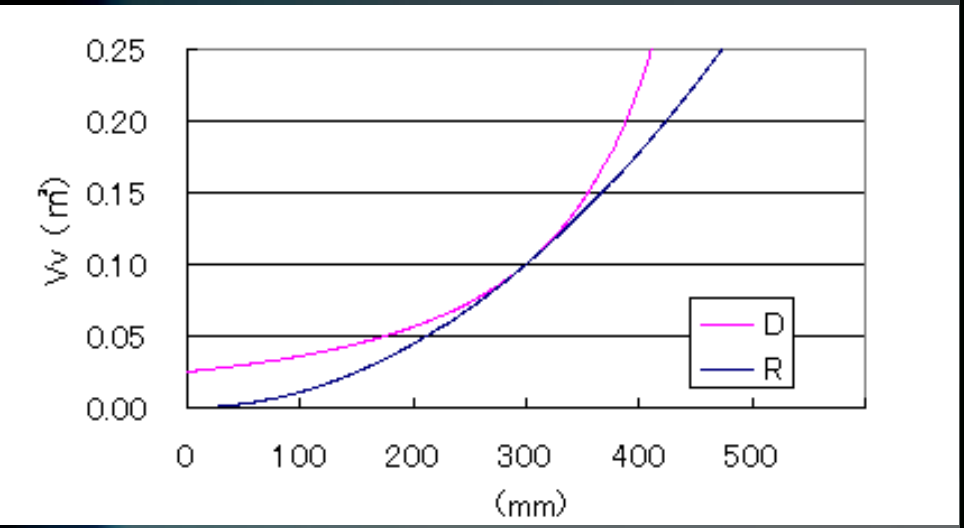


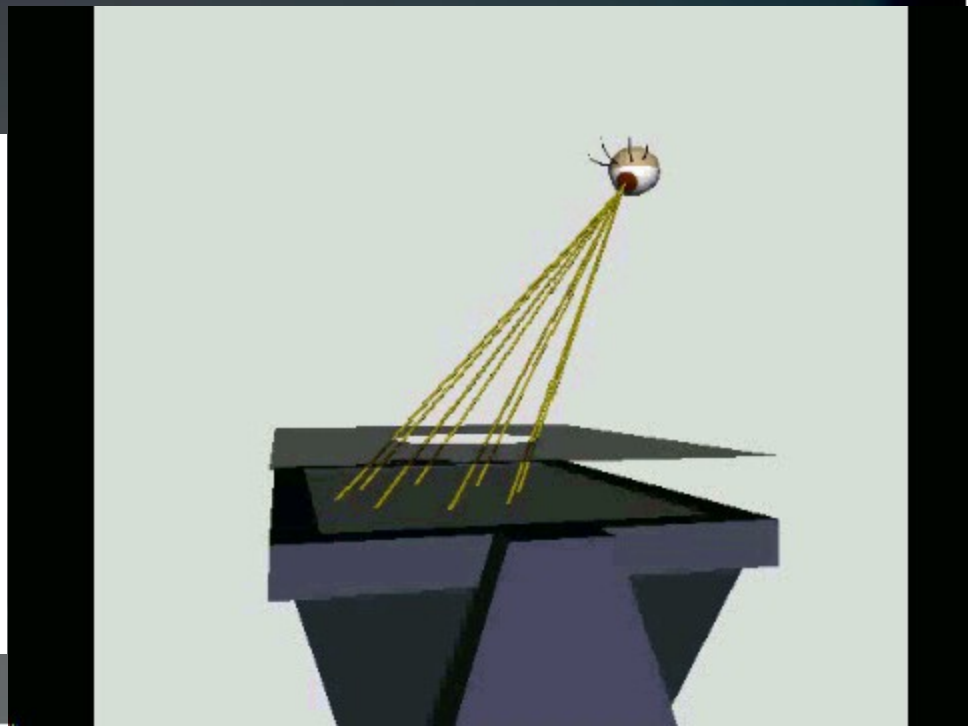


Viewing Volume for a User

$$V_v = \frac{\pi \cdot R^2 z_{eye}^3}{3(z_{eye} - D)^2}$$

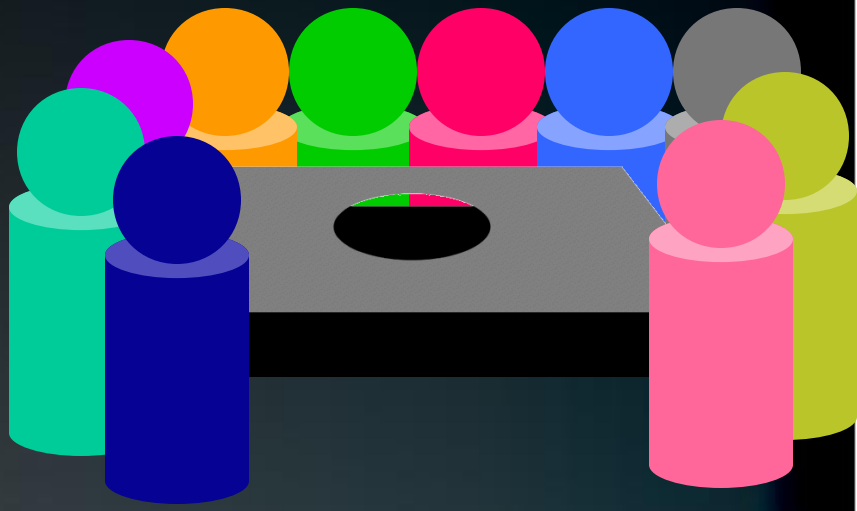


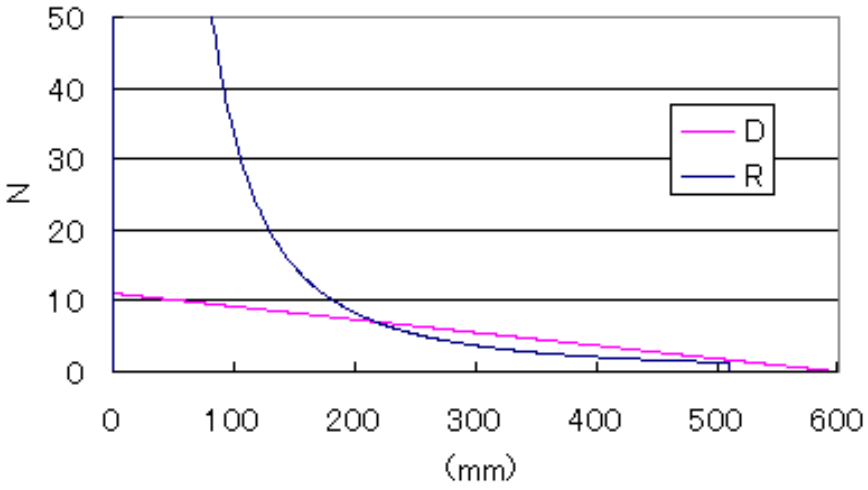


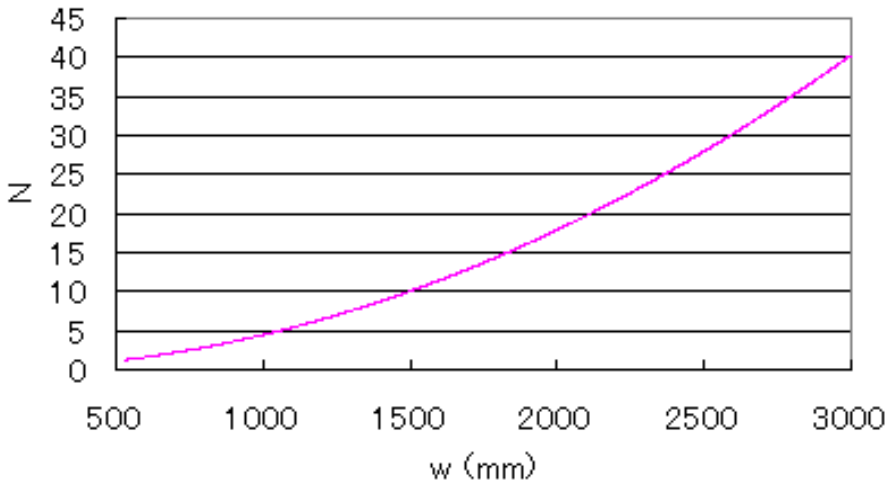


Maximum Number of Users

$$n_{users} \leq \frac{w \cdot h}{\pi \cdot R^2} \left[1 - \frac{D}{z_{eye}} \right]$$



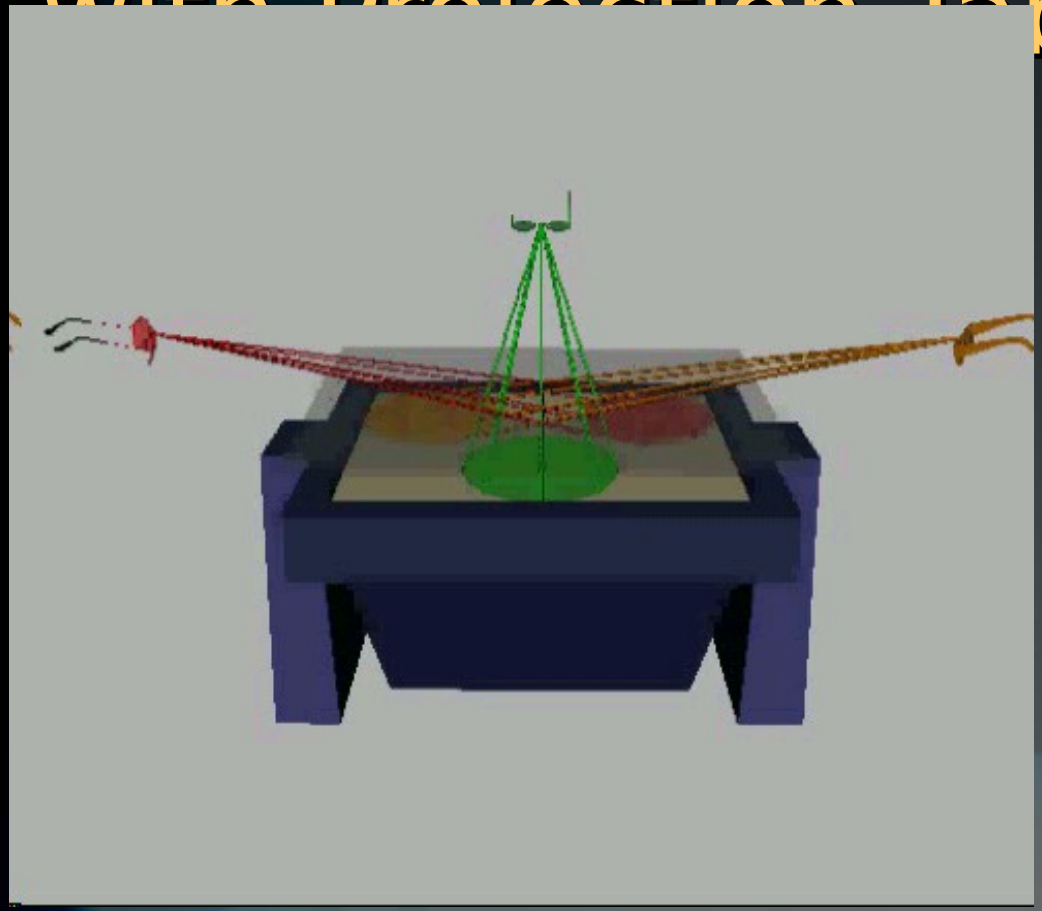




$w : h = 4 : 3$

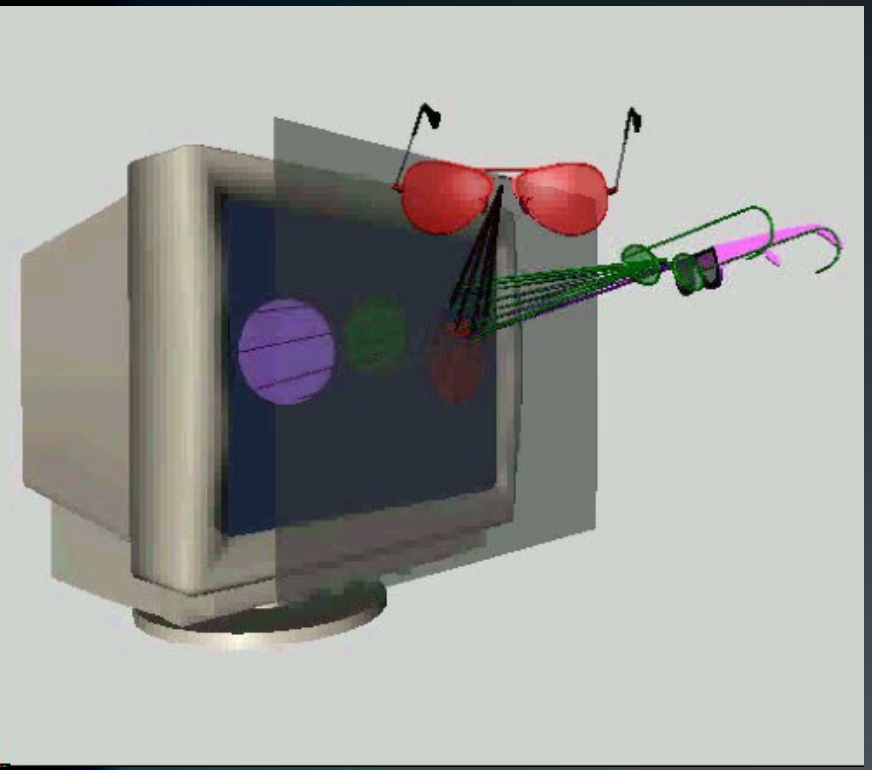
IllusionHole

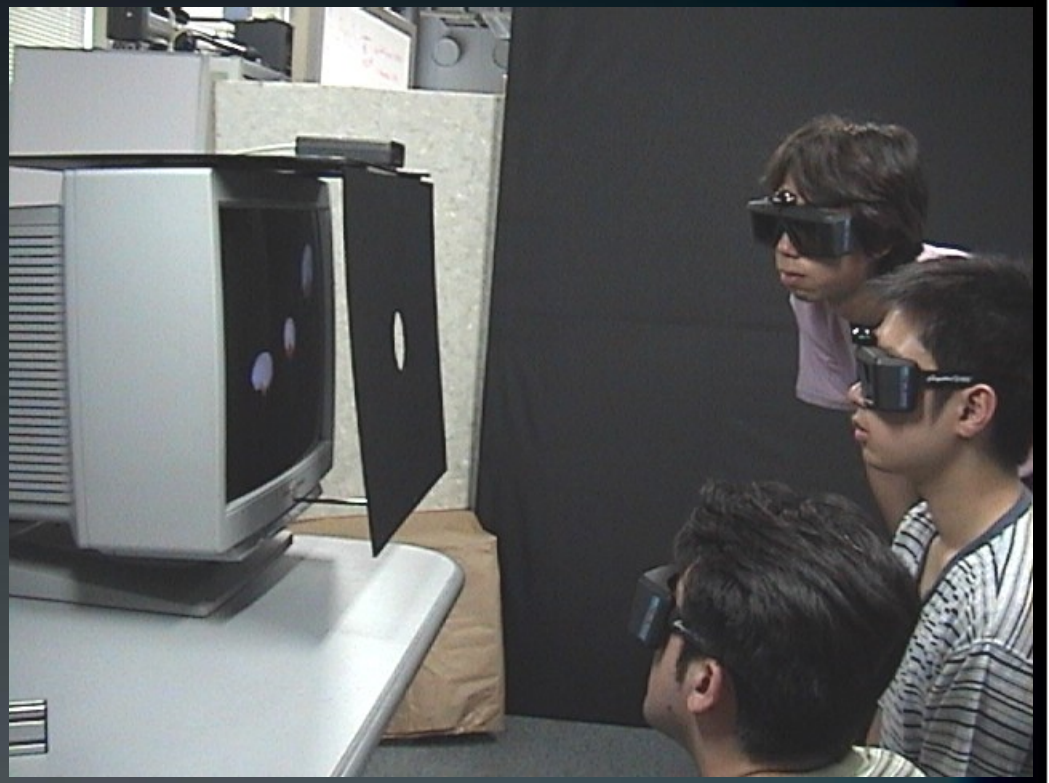
IllusionHole
with Projection Table



w = 1,320 mm
h = 1,020 mm
D = 150 mm
R = 200 mm

Desktop IllusionHole

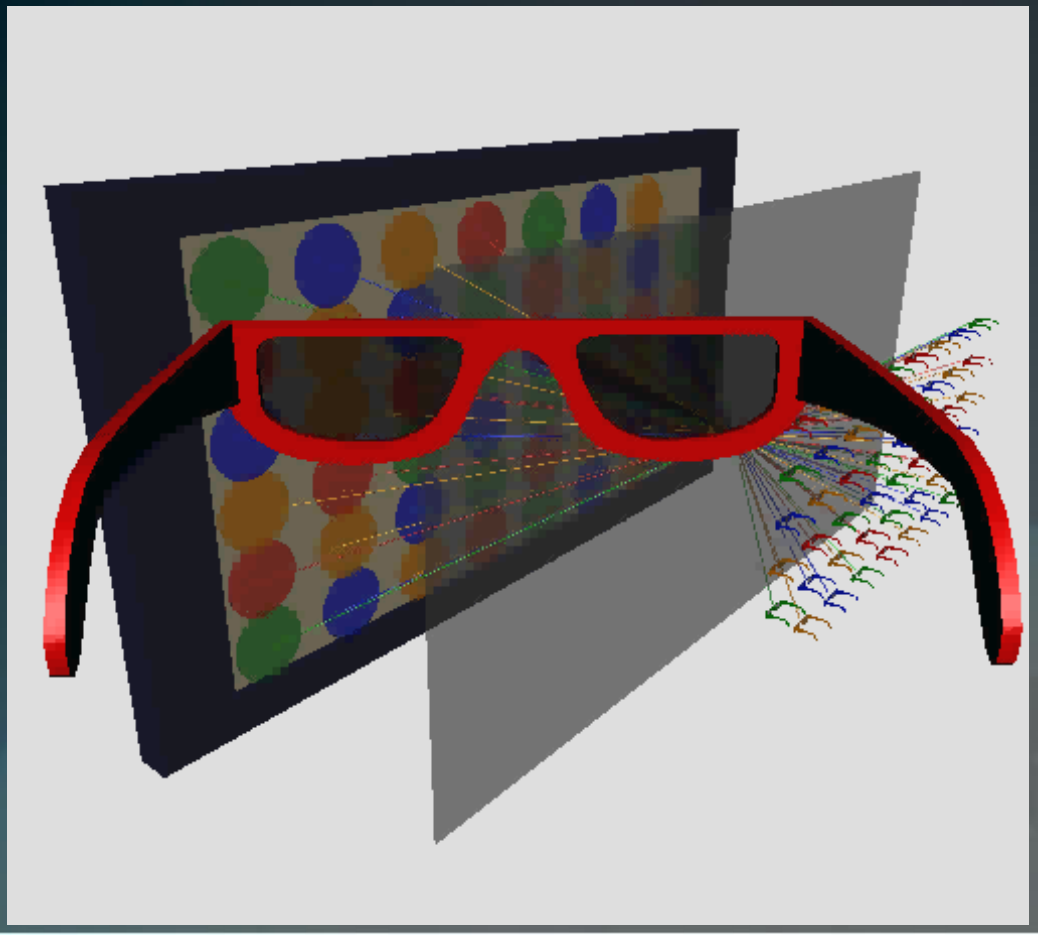




w = 400 mm
h = 300 mm
D = 150 mm
R = 35 mm

Future Work □ (1)

- Other IllusionHole configurations
  - Theater-type

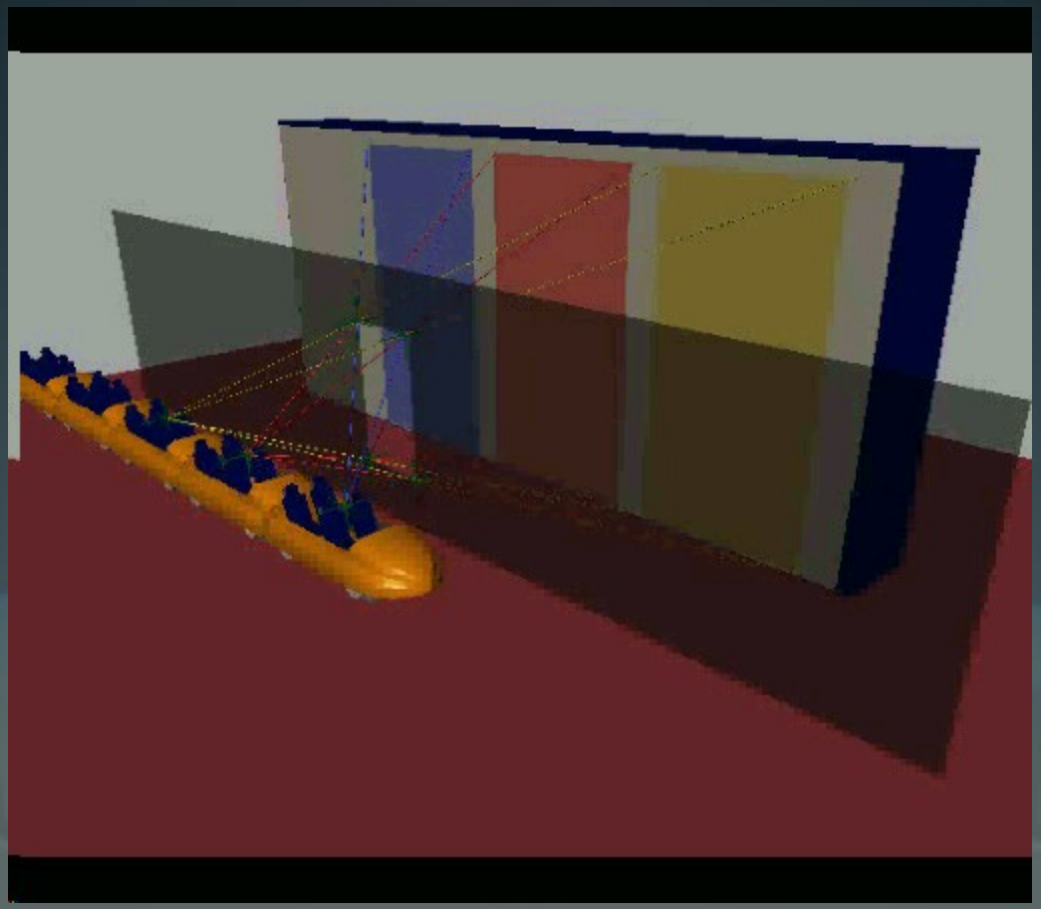


IllusionHole with
48 people

w = 25,000 mm
h = 18,000 mm
D = 6,000 mm
R = 500 mm

Future Work □ (2)

- Other IllusionHole configurations
  - Entertainment-type



Future Work (3)

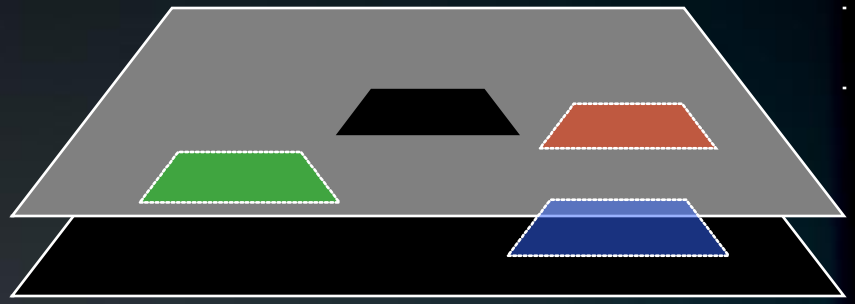
- Cooperative work environment
- Evaluation of IllusionHole

IllusionHole

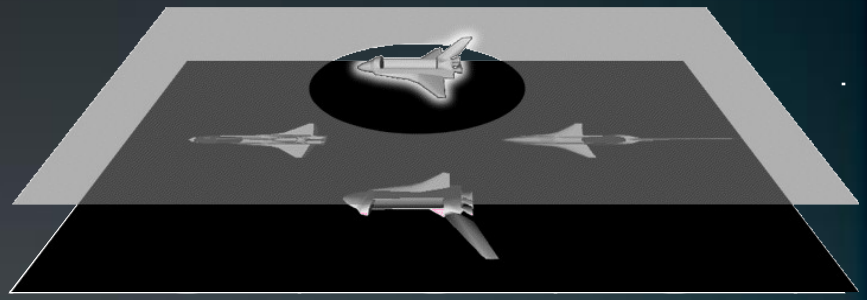
IllusionHole

Discussion

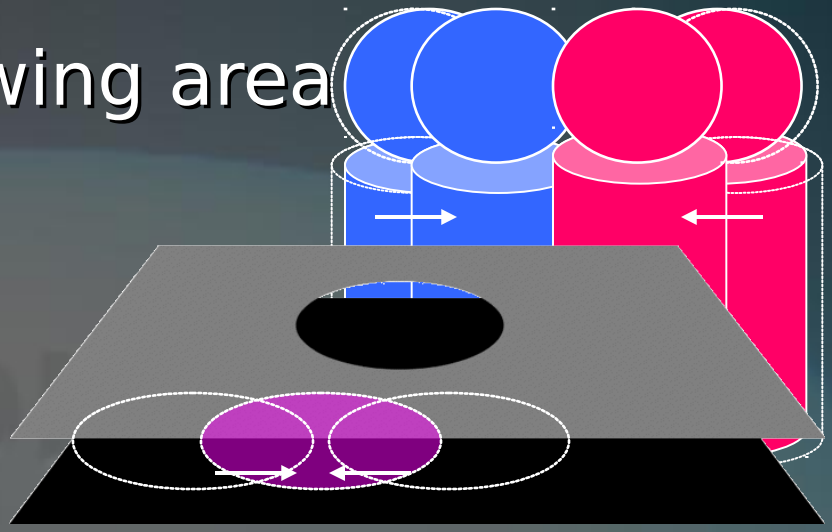
- Shape of the Hole



- Resolution of images

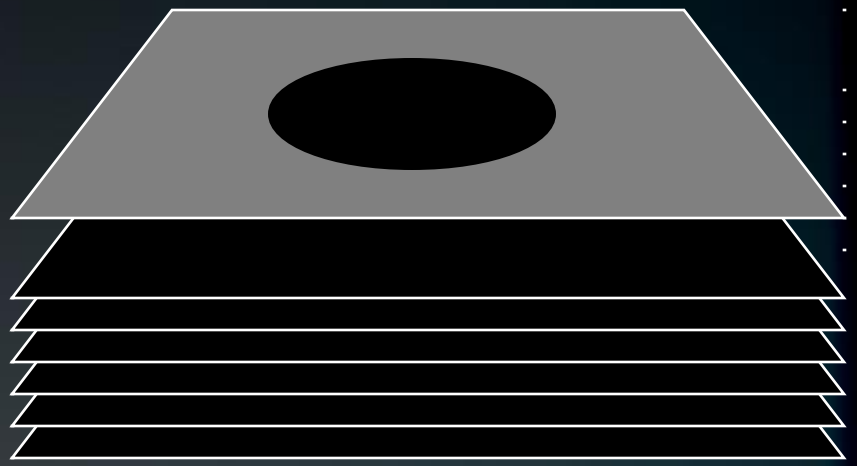


- Overlap of image drawing area

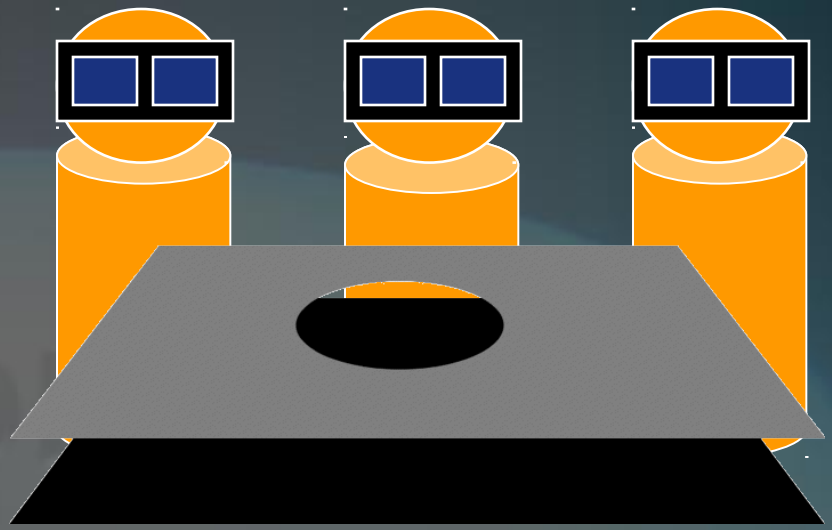


Discussion

- Design Parameters

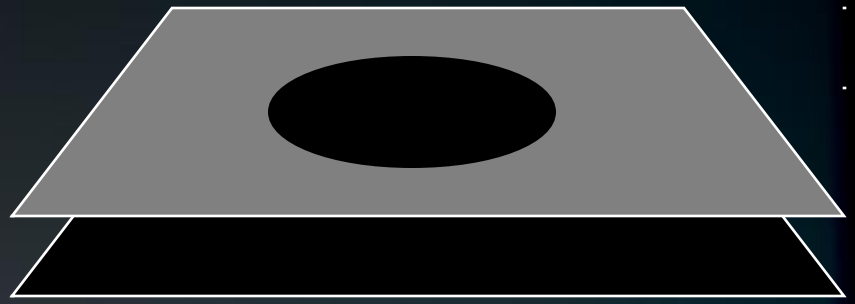


- Other Configurations



Discussion

- Design Parameters



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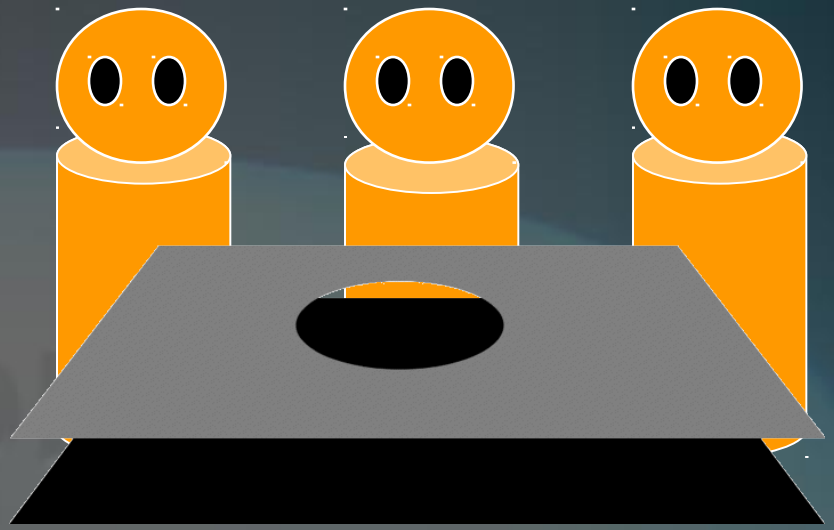

Summary

- Ideal interactive stereoscopic display for three or more users
  - with Motion parallax
  - without Distortion
  - without Flicker
  - with very simple configuration
- Idea & design issue
- Useful for cooperative work by sharing a physical workspace

IllusionHole

Demonstration

- Emerging Technologies
  - Until 3:00 p.m. tomorrow (Friday, August 17th)
  - At Concourse Hall

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http://www-human.eie.eng.osaka-u.ac.jp/IllusionHol

IllusionHole